COMPARATIVE ANALYSIS OF DIFFERENT FORECASTING TECHNIQUES: A CASE STUDY

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ABSTRACT :
As a key participant in the edible oil sector, the XYZ company understands the significance of precisely predicting future demand. Insufficient forecasting can result in difficulties managing product availability, such as stock shortages that fail to meet customer demands or overproduction that leads to financial setbacks. This study aims to assess the accuracy of demand forecasting for products A, B, C, and D, which are refined and manufactured by the XYZ company. By leveraging historical sales data, the research employs various time series forecasting techniques, including Moving Average, Weighted Moving Average, Exponential Smoothing, and other approaches. The objective is to determine the method with the lowest error rate to aid the company's planning for the upcoming months.
KEYWORDS - Demand forecasting, weighed moving Average, Time Series, and Mean Absolute Percentage Error.

INTRODUCTION :
In the current fast-paced environment and fierce business rivalry, organizations need to be decisive in their choices and to recognize forthcoming trends and prospects. Sales are a crucial element of a company's operations, playing a significant role in profit generation (Sasangka & Rusmayadi, 2018). Well-designed sales strategies enhance benefits, making sales forecasting an indispensable tool for planning. For companies focused on production, forecasting is essential as it helps to minimize costs and maintain appropriate inventory levels by estimating future demand (Heizer & Render, 2015). This procedure involves examining historical sales data to predict upcoming trends, thus enhancing operational effectiveness.

The initial phase of forecasting involves recognizing patterns in the data, which can be seasonal, stable, cyclical, or exhibit increasing or decreasing trends. There has been an increasing interest among researchers and professionals in forecasting techniques due to the variety of models that are available (Kurniawan et al., 2022). As noted by Hajjah and Marlim (2021), pinpointing the most precise forecasting method can assist businesses in making informed inventory choices, thereby reducing the chances of stock shortages or excesses.

This study seeks to aid XYZ firm in anticipating future market trends to sustain its competitive edge. Efficient planning in areas like scheduling, inventory oversight, and production is vital, as it lays the groundwork for effective operations (Karmaker, Halder, & Sarker, 2017). Accurate forecasting is crucial for identifying the ideal amount of chemical ingredients to distribute, which helps minimize excess inventory, boosts product availability, and increases customer satisfaction (Karmaker, 2017).

The purpose of this study is to determine the best forecasting technique for estimating the demand for XYZ Company by utilizing the Simple Moving Average, Weighted Moving Average, Exponential Smoothing method, and Time Series Method.

LITERATURE REVIEW :
Operation-Management
Within the subject of management, operations management is a crucial discipline that focuses on an

organization's operational components. Because it directly supervises a company's operational and manufacturing processes, it performs a vital function. According to Heizer and Render (2015), operations management is the process of turning inputs into outputs in order to provide goods and services. The process of efficiently using resources to plan and create products or services that aid in the accomplishment of corporate objectives is another definition provided by Hendrawaty (2018). Operations management, which is primarily in charge of delivering goods or services, is the core element of the production system, claim Stevenson and Chuong (2014).

FORECASTING: :
Because of its significance in organizational decision-making, forecasting is a topic of great scientific interest. It offers information that aids businesses in making future plans and creating plans to deal with impending difficulties. Forecasting, according to Wardah and Iskandar (2016), is estimating future values using historical data. According to Yuniastari and Wirawan (2017), businesses commonly employ forecasting to foresee future circumstances and assist in decision-making procedures meant to meet customer demand. Businesses can efficiently fulfill the demand for goods and services by estimating and predicting the resources and actions needed through forecasting.

SALE:
A company's greatest activity is its sales. This is due to the fact that these sales generate revenue. The amount of profit a business makes is also determined by how well its product is received by consumers. Selling, according to Triani et al. (2020), introduces, affects, and explains products or services so that consumers can locate them and come to a mutually advantageous agreement on a price. Sales are the transfer of ownership rights to goods or the provision of services through purchases at a mutually agreed price with the amount charged to the customer in the sale of goods or services in an accounting period, according to Ruiyanto & Hariyanti (2016). The sales volume obtained indicates the success of the sales business. According to Swastha (2012), there are five categories of elements that influence sales: seller conditions and capabilities, market conditions, capital, organizational conditions of the company, and other factors.

PRODUCTION :
Production, as described by Anil et al. (2008), is the gradual transformation of one type of material into another by a mechanical or chemical process in order to develop or improve the usability of the product for the consumer. Edwood Buffa describes production as the process of producing commodities and services (Anil Kumar & Suresh, 2008). In contrast, Hendrawaty (2018) asserts that production is the addition or creation of uses or utilities as a result of form and location, necessitating the application of production factors. Land, nature, capital, labor, capacities, and technology are the components of production in economics.

INVENTORY:
The management of inventory is a crucial function for any organization, as it represents a significant component within the retail industry (Setiyanto, Nurmaesah, & Rahayu, 2019). As noted by Swasono and Prastowo (2021), inventory constitutes an asset that a company possesses and is prepared for sale in pursuit of its business objectives. Specifically, merchandise inventory refers to the products that a company retains for the purpose of resale. From the perspective of its definition, inventory plays a vital role in a trading enterprise, as it influences the operational processes of the company. Furthermore, inventory serves as a form of investment in potential profits that can be realized through future sales (Ramdhany & Kurnia, 2016).

MOVING AVERAGE:

Moving average or moving average is a forecasting method from a group of observational data. It calculates the average value of the data as a forecast value for the next period. Forecasting using the moving average method performs a calculation process from the most recent data values and deletes old data values (Hajjah & Marlim, 2021). The moving average method can be calculated using the following equation.

$$F_t = \frac{\sum(Data\ requests\ n\ previous\ periods)}{n}$$

Ft=Σ Data requests n previous periods

Ft = forecasting value in period t

Σ = Total data requests for the previous period

n = The number of data periods of the moving average

WEIGHTED MOVING AVERAGE :

The moving average model uses many new actual demand data to produce an estimated future demand value (Nugroho, 2017). The Weighted Moving Average (WMA) method is suitable for using time series data, namely, data that changes from time to time (Palmitraazzah et al., 2017). WMA forecasting method is a development of the moving average method with additional weight in the calculation. WMA is an average that is calculated by giving values in a data set that is more influenced by data attributes, whereas the average calculation is done by weighting. In simple terms, WMA is a moving average that is given a weight for each data. The advantage of WMA is that each historical data is given a different load value, and in the latest data, the load value is getting bigger, the forecast will be more accurate because more relevant data is given a higher weight in forecasting (Solikin & Hardini, 2019).

EXPONENTIAL SMOOTHING :

Exponential smoothing or exponential smoothing is a moving average forecasting method with a sophisticated weighting system but is still easy to use. The exponential smoothing method is generally used to predict data with irregular patterns or patterns with large and volatile changes (Hajjah & Marlim, 2021).

In this method, the past data are weighed in an unequal fashion while estimating the future period's forecast. Moreover, there is a smoothening effect in this process as the weights of the past data die down in an exponential fashion. In this method, the forecast for the next period is computed on the basis of the forecast for the current period and the actual demand during the current period.

Since there is likely to be a difference between the forecast and the actual demand, the difference is incorporated in the next period's forecast.

$$Ft = Ft-1 + α\ (At-1 - Ft-1)$$

Ft = New forecast

$Ft-1$ = Previous forecast

α = Smoothing constant

$At-1$ = Actual demand for the previous period

ESTIMATING THE TREND USING LINEAR REGRESSION :

The simplest method to estimate the trend in a time series is to treat the time periods as independent variables and the actual demand as a dependent variable. Using the standard method of least squares, it is possible to estimate the trend component. Consider the following notations pertaining to a time series:
Xi = Time periods (in a monthly time series data for 2 years, X will vary from 1 to 24)
Yi = Actual demand during Period Xi
Then, a simple linear regression of the form Y = a + bX could be constructed to predict the demand Y for any value of
X using the equation, where
a = Intercept (at Period 0)
b = Slope of the line
X = Time period
Y = Forecast for the demand Period X
The coefficients of the regression equation could be computed using the method of least squares:

$$b = \frac{\sum_i X_i Y_i - n\overline{X}\,\overline{Y}}{\sum_i X_i^2 - n\overline{X}^2}$$

$$a = \overline{Y} - b\overline{X}$$

where n is the number of periods,

$$\overline{X} = \frac{\sum_i X_i}{n}$$

$$\overline{Y} = \frac{\sum_i Y_i}{n}$$

Forecasting techniques such as exponential smoothing, time series analysis, weighted moving averages, and simple moving averages have been extensively utilized in various research studies. The choice of forecasting method can significantly influence the quality and precision of the predictions made. To evaluate the effectiveness and accuracy of these forecasting approaches, several statistical measures are employed, including Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE). By comparing these metrics across different methods, one can identify the most reliable forecasting technique.
Among the three statistical measures assessed, Mean Absolute Percentage Error (MAPE) is considered more informative than both Mean Absolute Deviation (MAD) and Mean Square Error (MSE). MAPE provides insights into whether the percentage error of the predicted values is excessively high or low.

METHODOLOGY :
This research utilizes a quantitative methodology, which is appropriate for tackling research inquiries that require numerical and statistical evaluation. Among the techniques applied in this study are the Single Moving Average and Single Exponential Smoothing, both of which are recognized time series forecasting methods. These time series techniques depend on the examination of historical data trends to extrapolate future outcomes through mathematical and statistical modeling. The research process initiates with a comprehensive literature review aimed at uncovering potential solutions to the research issue and culminates in the presentation of findings and recommendations.

DATA COLLECTION :

The research employs sales datasets to evaluate the forecasting model. The data utilized for this analysis was sourced directly from XYZ Company. This study focuses on processing demand data for Products A, B, C, and D, covering the period from January 2020 to August 2024. In this section, we will simulate the calculations of Moving Average, Weighted Moving Average, Exponential Smoothing, and Time Series methods for Products A, B, C, and D. The objective is to identify the most effective forecasting method for these products, enabling XYZ Company to maintain its competitiveness in the global market.

DATA USED :

Data was gathered from XYZ Company for this study. The dataset comprises demand information for Products A, B, C, and D, covering the period from January 2020 to August 2024. This dataset includes both the time frame and the corresponding demand figures for each product.

RESULTS AND CONCLUSION :

Summary of MAPE of Different Forecasting Techniques								
Product	Simple Moving Average Method	Weighted Moving Average Method		Exponential Smoothening		Linear Regression		
		wt1: 10,30,60	wt2: 25,30,45	α = 0.2	α = 0.8	24 months	36 months	48months
Product A	1.45%	1.49%	1.45%	1.92%	1.49%	10.83%	6.37%	3.62%
Product B	0.23%	0.22%	0.22%	0.22%	0.22%	0.29%	0.21%	0.21%
Product C	0.44%	0.40%	0.42%	0.44%	0.38%	1.05%	0.66%	0.53%
Product D	0.26%	0.26%	0.26%	0.44%	0.38%	1.05%	0.66%	0.53%

We used the weighted moving average approach in two different methods for this investigation. i.e. by allocating weights in two patterns, namely $10\%, 30\%, 60\%$ and $25\%, 30\%, 45\%$.

We applied values of α, 0.2 and 0.8 to the exponential smoothening approach, respectively. We carried out the computation in three distinct ways while calculating the forecasting using linear regression. First, we projected the remaining months after using 24 months of data for the computation. For additional analysis, we also froze data for 36 and 48 months. We found that we achieved the lowest percentage of error when we used a larger dataset for our calculations.

According to the analysis, linear regression is most suited for product b, whereas the simple moving average approach yields the least error for product a. The basic moving average and weighted moving average methods produce the least amount of inaccuracy for product d, while the exponential smoothing method is more effective for product c.

Various approaches produce the lowest or minimal value of MAPE for the different datasets.

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